

User-modelled Ambient Feedback for Self-regulated Learning

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Abstract. A fundamental objective of human-computer interaction research is to make systems that are seamlessly integrated into daily life activities. Hence, the challenge is not only to make information available to people at any time, at any place, and in any form, but specifically to say the right thing at the right time in the right way. On the other hand, the proliferation of sensor technology is facilitating the scaffolding and customization of smart learning environments. This manuscript presents an ecology of resources comprising NFC, BLE and Arduino technology, orchestrated in the context of a learning environment to provide smoothly integrated feedback via ambient displays. This ecology is proposed as a suitable solution for self-regulated learning, providing support for setting goals, setting aside time to learn, tracking study time and monitoring the progress. Hereby, the ecology is described and intriguing research questions are introduced.

Keywords. Feedback, Near-Field-Communication, BLE-Beacons, Arduino, Time-management, Learning analytics, Ambient display

1 Introduction

Providing in-context support and feedback is key to identify the best learning moments and self-organize the learning day. Lifelong learning implies setting aside regular time for learning during the day as well as combining learning activities with daily life activities (i.e. family, work, leisure). Nevertheless, daily contingencies and their varying priorities make specially challenging to provide technological support for lifelong learners in the task to set realistic goals, set aside daily time to learn, track the time devoted to learn, and monitor learning progress. In previous research, we investigated different ways to provide feedback services fostering the competence of *learning to learn*, using SMSs [1] and mobile chart visualizations [2] as channels to provide guidance from the teacher. The differentiation among external and internal feedback is crucial if one investigates the effects of feedback on the basis of recent instructional models viewing the process of knowledge acquisition as a self-regulated learning process [3]. Hence, hereby we present a smart learning ecology in which lifelong learners are able to customize internal feedback based on their own occasional learning priorities and contingencies.

2 Smart Ecology of Resources for Time Management

Candy [4] summarized four components of self-directed lifelong learning: self-monitoring, self-awareness, self-management and meta-learning. The challenge in an information-rich world is not only to make information available at any time, at any place, and in any form, but specifically to say the right thing at the right time in the right way [5]. This ecology provides self-regulated support for lifelong learners tracking time devoted to learn, orchestrating sensor technology, and modelling ambient feedback.

The NFC-LearnTracker [6] is an open source mobile application developed for NFC-enabled devices that features learning analytics of time devoted to learn based on the timestamps recorded every time the user starts *check-in* and stops *check-out* a self-defined learning goal. The evaluation of the NFC-LearnTracker [7] concluded that it is a useful tool to set and adjust mini-goals, to foster awareness on preferred learning environments, and to integrate learning in daily activities.

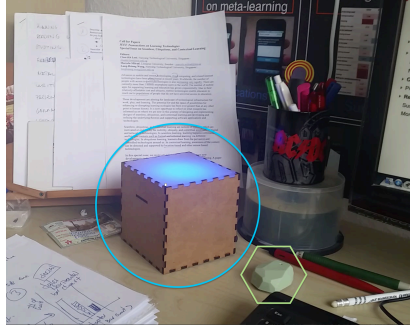


Fig. 1. Feedback cube & BLE-beacon



Fig. 2. NFC-Tags bound to learning activities

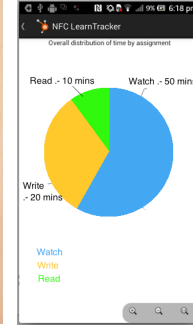


Fig. 3. NFC LearnTracker

The NFC-LearnTracker interprets the information provided by the following sensors:

- NFC tags (Fig. 2 See blue squared). As illustrated in Fig. 3, an overall learning goal (i.e. learn Dutch) comprises a set of sub-goals (watch videos; write texts; read news) that are assigned a coloured tag (blue; orange; green), an estimated daily time in minutes (50; 20; 10), and a deadline date to accomplish each sub-goal.
- Bluetooth Low Energy (BLE) beacons (Fig 1a. See green hexagon). BLE-beacons are being novelty used to provide proximity-adapted feedback in the field of shopping¹, access control, and home entertainment. Hereby, we use BLE-beacons to monitor student's progress when he approaches or moves away from the beacon.

The Feedback Cube [8] (Fig. 1) is an ambient learning display [9] built-on an Arduino microcontroller that provides visual and audio feedback (Fig. 3). The used LEDs are

¹ Estimote Beacons. <https://www.youtube.com/watch?v=sUIqfjpInxY> .(Last accessed 29/06/2015)

² Feedback Cube effects in video:

<https://sites.google.com/site/lifelonglearninghubproject/home/feedback-cube> . (Last accessed

capable of displaying the full RGB colour space with 16777216 colours at 256 brightness levels (Fig. 5). All 16 RGB LEDs on the ring can be controlled individually, which allows programming various visual patterns (i.e. Fig. 6 matches pie chart in Fig. 3) and effects, such as fading, blinking, or colour transitions. The used mini speaker can reproduce programmatically created audio patterns and effects, such as playing single tones, complex melodies, or even encoded audio files.

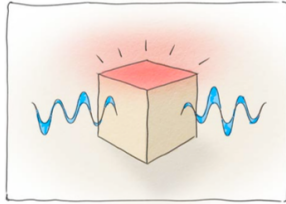


Fig. 4. Visual and audio effects

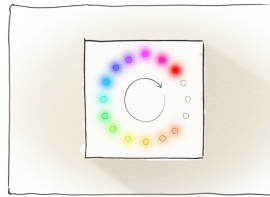


Fig. 5. Rainbow effect

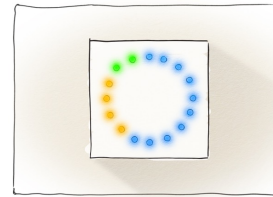


Fig. 6. Piechart effect

3 Mapping Events and Feedback

The NFC-LearnTracker lets the user configure which feedback signal fits better each one of the events listed below. Hereby we present the events supported and their default set-up:

Table 1. Default configuration of the ecology²

Event	Action	Feedback
On approach	The user moves closer to the BLE beacon	Summarize! The cube lights a pie chart indicating the distribution of time for pending tasks (Fig. 6)
On check-in	The user taps on the NFC tag every time an activity is started.	Start! The cube lights the blue colour (Fig. 1) to indicate your are working on the blue learning goal
On check-out	The user taps on the NFC tag to stop a learning activity.	Stop! The cube switches off the existing light
X minutes before expiring the estimated time for a goal in a day	X minutes before time expires	Time to wrap up! The cube slowly fades X' times to gently advice that time will expire in X minutes.
On expiry estimated time for a goal in a day	Time expired	Time just expired! The cube beeps once providing a more intrusive notification

² Feedback Cube effects in video:

<https://sites.google.com/site/lifelonglearninghubproject/home/feedback-cube> . (Last accessed 29/06/2015)

Y minutes after expiring the estimated time for a goal in a day	Y minutes after expiring	Overworking! The cube fades faster Y' times warning that you exceeded Y minutes your scheduled time.
On accomplishment of all goals in a day	On check-out the last goal	All daily goals accomplished! The cube lights a rainbow to congratulate the user
On accomplishment of one-goal deadline date	Scheduled date to finish one goal	Learning goal accomplished! The cube plays a melody indicating the goal is finished
On accomplishment of all-goals deadline date	Scheduled date to finish the last goal	All goals accomplished! The cube lights a rotating rainbow to congratulate the user
On move away	The user moves away from the BLE beacon	Summarize! The cube beeps Z' times summarizing pending study time (e.g. 30 minutes pending beeps 3 times)

4 Future Work

In further research, the quality of the learning analytics via mobile visualizations (Fig. 3) and displays (Figs. 4-6) will be contrasted and evaluated [10]. Additionally, we will explore whether internal feedback services might improve self-regulated learning.

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